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FOODPLANT ECOLOGY OF THE BUTTERFLY *CHLOSYNE LACINIA* (GEYER) (NYMPHALIDAE)

III. ADULT RESOURCES

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Much data exists for many rhopalocera species concerning larval foodplants. Such information is of obvious importance in the study of the ecology and evolution of any particular species. For many years, however, another important aspect of rhopaloceran biology has been generally ignored—the importance of adult energy sources. Some moth species have dispensed with adult feeding, thus depending entirely upon the larval stage for acquisition of energy stores. This evolutionary event has not been observed in rhopalocerans, however; much important data remain to be collected on various butterfly species. Norris (1936) produced an early review of the topic but little more was published on this topic until the 1970's.

Recently, this aspect of rhopaloceran biology has received more attention by various workers. Shields (1972) reviewed literature references and added personal records but little synthesis was attempted. An extreme example of butterfly-plant mutualism involving the coevolution of *Heliconius* butterflies and *Anguria*/*Guranea* pollen and nectar plants has been studied by Gilbert (1975). Gilbert (1972) earlier reported the assimilation of pollen proteins by *Heliconius*. Pollen-fed *Heliconius ethilla* lay more than five times as many eggs as those without pollen. Obviously, adult resources are a possible topic of much discussion and importance. Not all adult resources of lepidoptera are supplied by plant products; Downes (1973) discussed mud puddles, dung and carion in this respect.

During the process of collecting data concerning the larval foodplant ecology of *Chlosyne lacinia* var. *adjutrix* Scudder

(Nymphalidae: Melitaeinae), observations were made concerning adult acquisition of energy and/or water resources. These data are not as comprehensive as the larval foodplant data, but what is available is presented here. All observations occurred in central Texas centering in Austin, Travis County.

ADULT RESOURCES

Verbesina encelioides (Cav.) Gray. This plant is the major source of nectar for *adjutrix* during the fall months when *V. encelioides* serves as a primary nectar source for all butterflies. Quite possibly, *adjutrix* has some advantage over other butterfly species in utilization of this plant as a nectar source because females do not have to leave the area to oviposit on the proper foodplant. *V. encelioides* is the second most commonly utilized foodplant of *adjutrix;* during the fall months *V. encelioides* is by far the major foodplant of this butterfly.

Helianthus annuus L. Nectar of this plant is utilized at times, but generally it is not very acceptable to adult *adjutrix. H. annuus* can be best classified as a "bee plant" in reference to flower visitation; honey bees and bumble bees are the most frequent visitors to this plant. This is the primary larval foodplant of *adjutrix,* particularly during the spring and early summer months. The general unsuitability of this plant as a nectar source for *adjutrix* does not affect its utilization as a larval foodplant because various annuals associated with stands of sunflowers are prime nectar sources.

Heterotheca latifolia Buckl. This species is a prime nectar source for *adjutrix* especially in association with *H. annuus* over which *H. latifolia* is utilized. *H. latifolia* tends to be ignored in the presence of *V. encelioides.*

Verbesina virginica L. This plant does not bloom until the fall; at this time it may serve as a temporary prime nectar source. This plant is probably utilized to a lesser extent by *adjutrix* than other butterflies because *V. virginica* occurs in wooded areas of central Texas; *adjutrix* tends to avoid such shaded areas.

Zexmenia hispida (H.B.K.) Gray. The small inflorescences of this species are utilized by *adjutrix* during the lengthy blooming period (late spring to fall). This plant is classified as an "occasional" larval foodplant (Neck, 1973).

Viguiera dentata (Cav.) Spreng. This plant, also an "occasional" larval foodplant, is utilized by adult *adjutrix* during blooming season which is restricted to the fall months.

Gaillardia pulchella Foug. The colorful inflorescences of this species may supply nectar to *adjutrix* adults during spring and early summer. *H. latifolia* appears to be preferable to *G. pulchella* which has "rarely" been utilized as an *adjutrix* larval foodplant (Neck, 1973).

Eysenhardtia texana Scheele. This plant is an important periodic source of nectar. Flowers generally appear in late spring and fall but react mainly to rainfall.

Lantana horrida H.B.K. and *Lantana macropoda* Torr. Adult *adjutrix* have been observed at the flowers of these species but the plants generally appear to be ignored. These two species are major nectar sources for swallowtail and heliconian butterflies. Possible factors involved in the low utilization of *Lantana* by *adjutrix* will be discussed later in this article.

Rubus trivialis Michx. The blossoms of dewberry are utilized as nectar sources in early spring, particularly if alternate sources are uncommon. Such is often the case during a dry early spring which follows a dry winter; few annuals germinate and produce blossoms early in the season. When other suitable flowers begin to appear, *R. trivialis* is ignored by *adjutrix*.

Several plants common in areas frequented by *adjutrix* are apparently ignored by this species although not necessarily by other butterflies. *Verbena bipinnatifida* Nutt. is frequently visited by *Battus philenor* (L.), for example. *Lupinus texensis* Hook. is primarily visited by bees. *Phlox drummondii* Hook. is apparently ignored by *adjutrix* although the major pollinators of plants of this genus are butterflies of the genus *Colias* (see e.g. Levin, 1969).

Non-floral adult resources are also known for *adjutrix*. Adults in predominantly male groups may be seen congregated at water holes (as previously reported by Bauer, 1953, in Arizona), especially under high adult density conditions when the nectar supply may be insufficient. After reviewing the literature of lepidoptera visits to dung, carrion and puddles, Downes (1973) concluded that these visits functioned to obtain some unidentified nutrient. Studies by Arms et al. (1974) revealed that male *Papilio glaucus* were attracted to sand soaked with sodium salts. These results were interpreted as adult supplement of a larval diet deficient in sodium. Male *adjutrix* have been observed to feed on carrion and feces when sufficiently moist. Several other melitaeine butterflies have been reported as feeding at mud puddles and carrion (Voss, 1954, Payne and King, 1969). Dur-

ing a summer picnic a single male *adjutrix* was observed to feed on a piece of fresh watermelon rind for approximately thirty minutes.

DISCUSSION

Nectar sources heavily utilized by *adjutrix* are, for the most part, general "butterfly flowers" as far as flower visitors are concerned. Faegri and van der Pijl (1966) remark that butterflies, generally speaking, "seem to prefer sucking nectar out of narrow tubes, frequently florets of Compositae." Nine of the eleven plants listed above have tubular flowers; seven are Compositae.

Blossom color preference has been shown in several butterfly species (Dronamraju and Spurway, 1960). The blossom colors of the most important nectar sources of *adjutrix* are yellow (*V. encelioides, H. annuus, H. latifolia, Z. hispida* and *V. dentata*), white (*V. virginica, E. texana* and *R. trivialis*) and red/yellow (*G. pulchella*). Blossom color of those common plants which were noted as being ignored are purple, blue and pink. Detailed quantitative field data will be required to determine whether these color differences between utilized (yellow-white) and non-utilized (blue-pink) are truly significant but a strong tendency has been demonstrated. Levin (1969) reported that both corolla color and outline influence the number of visits by butterflies to *Phlox* blossom. Work with *Heliconius charitonius* has revealed results that were interpreted as "spontaneous" color preferences (Swihart and Swihart, 1970) which may be modified by "conditioning" (Swihart, 1971). These reported "spontaneous" color preferences may have been due to conditioning, however, because wild-caught specimens were utilized in the original experiments. One would expect a preference for a particular flower or group of similarly shaped and/or colored flowers to occur through experience or "conditioning". Exceptions concerning instinctual, i.e. genetic, preferences will occur in highly co-evolved butterfly-plant systems (e.g. Gilbert, 1975).

Studies by Knoll (1926) and Ilse (1928) as reviewed by Norris (1936) has revealed variation in methods utilized by rhopalocera to locate nectar sources. Certain butterflies, e.g. *Papilio* and various pierids, appear to be attached to blossoms entirely by visual cues. Other species, e.g. charaxine nymphalid species, are guided to food sources entirely by olfactory cues. Ilse (1928) reports that most butterflies, however, utilize both classes of cues and therefore comprise an intermediate group in

continuum. Odor is probably largely utilized by *adjutrix* to locate feces, carrion and puddles. Flowers may be located by a combination of the senses. Restriction of the major nectar sources to blossoms of white or yellow color classes indicates that vision is important. The near lack of utilization by *adjutrix* of *Lantana,* which is widely used by such visually-oriented butterflies as *Papilio,* would tend to indicate that vision is not of prime importance. Alternately, the pigments present in *Lantana* corollas may be quite different from the pigments present in corollas of the prime nectar sources.

There is no necessarily direct relationship between larval foodplant and adult nectar plants. However, observations of *adjutrix* populations suggest that subtle interacting influences may exist between these energy sources for the two active phases of its life cycle.

Previously (Neck, 1973), I stated, "pure, isolated" stands of *A. trifida* had never been observed to be infested by *adjutrix.* Since that statement was published, a few broods have been found in isolated stands of giant ragweed. Such utilization is of uncommon occurrence. The important factor does not appear to be lack of adult female oviposition stimulation by either *H. annuus* or *V. encelioides* as previously suggested (Neck, 1973). Lack of concentration of adults due to absence of sufficient nectar sources for adult energy requirements seems to be the significant factor (See Neck, ms.) *V. encelioides* is a prime source for *adjutrix* and many other insects. *H. annuus* is only a minor nectar source for *adjutrix,* but plants associated with sunflower are important nectar sources. *A. trifida* produces little, if any, nectar, being anemophilous (wind-pollinated). Therefore, adult *adjutrix* are not as attracted to ragweed as to other larval foodplants because of lack of nourishment source. Larval infestations on giant ragweed tend to be heavier in areas where disturbance of the soil has allowed colonization by other annuals which are a nectar source for this butterfly.

Both *Zermenia hispida* (H.B.K.) Gray and *Viguiera dentata* (Cav.) Spreng. are rated as "occasional" larval foodplants of *adjutrix* (Neck, 1973, ms.). *Z. hispida* appears to be preferred to *V. dentata* as a larval foodplant. (unpub. data). Such a preference is somewhat surprising as the genus *Viguiera* is very closely related to *Helianthus* (Heiser, 1969). The smell of crushed leaves of *V. dentata,* to the human nose, is very similar to the smell of crushed leaves of *Helianthus annuus,* the primary

larval foodplant of *adjutrix* in central Texas. One possible factor favoring utilization of *Z. hispida* is the lengthy blooming season (late spring to fall) of this species in contrast to the restricted blooming season (fall) of *V. dentata*. An adult female *adjutrix* which is attracted to flowers of *Z. hispida* is more likely to detect individuals of this species as acceptable ovipositional substrates than individuals of *V. dentata* which supplies no such visual attraction during much of the year.

Utilization of *Verbesina virginica* as a larval foodplant is quite limited but is more likely to occur during the fall months (unpub. data). As this period of the year is also the blooming period of this species, adult attraction to flowers for nectar could increase the utilization of this plant.

Adult resources are of such importance that they represent a potential limiting factor in the growth of *adjutrix* populations. While the presence of various sugars in nectar (Wykes, 1952; Van Handel et al., 1972) has long been known and/or assumed, recent work has revealed that nectar of many species contain amino acids (Baker and Baker, 1973) which could be utilized by butterfly visitors. Initial investigations have revealed that butterfly-pollinated blossoms tend to be richer in amino acids than bee-pollinated flowers (Baker and Baker, 1973b). The lack of protein supplied by nectar may limit the reproduction of *adjutrix* even if moderate amounts of larval foodplant material are available.

The effect of nectar shortage is not likely to be as dramatic in *adjutrix* populations as in populations of *Heliconius ethilla* which has intensively co-evolved with its pollen sources (Ehrlich and Gilbert, 1973). However, observations of natural populations of *adjutrix* indicate that nectar is extremely important, at times, as a limiting factor. Early 1970 was a time of abundant larval foodplant material, but very low population levels of *adjutrix* were present. As a result of deficient rainfall, a greatly reduced amount of nectar was available because few individual plants were blooming. A similar situation was observed in spring 1976.

SUMMARY

Adult resources (nectar, dung, carrion and mud puddles) of *Chlosyne lacinia* var. *adjutrix* as observed in central Texas are discussed. Numerous plants supply nectar to *adjutrix* but flowers with white or yellow corollas are favored. Primarily males are

attracted to dung, carrion and mud puddles. Relative roles of visual and olfactory cues in location of resources are discussed. An indirect relationship between larval foodplant utilization and adult resource utilization is postulated. At times adult resources are believed to be a limiting factor in the growth of populations of *adjutrix*.

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